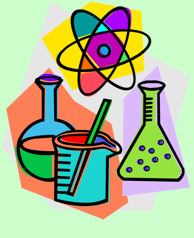
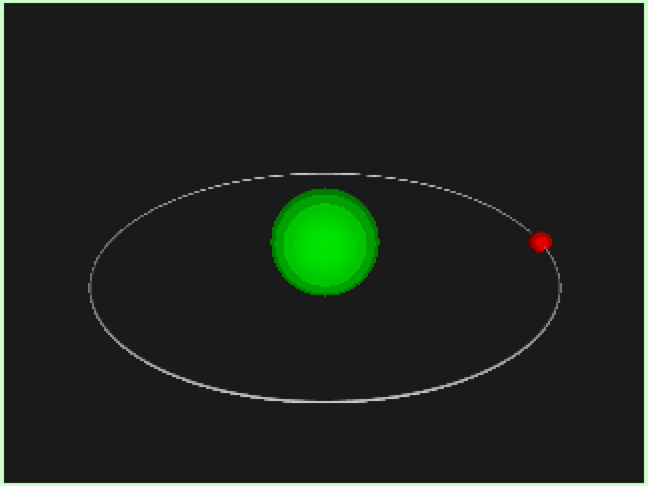
ELECTRON CONFIGURATION



Bohr Model of the Atom

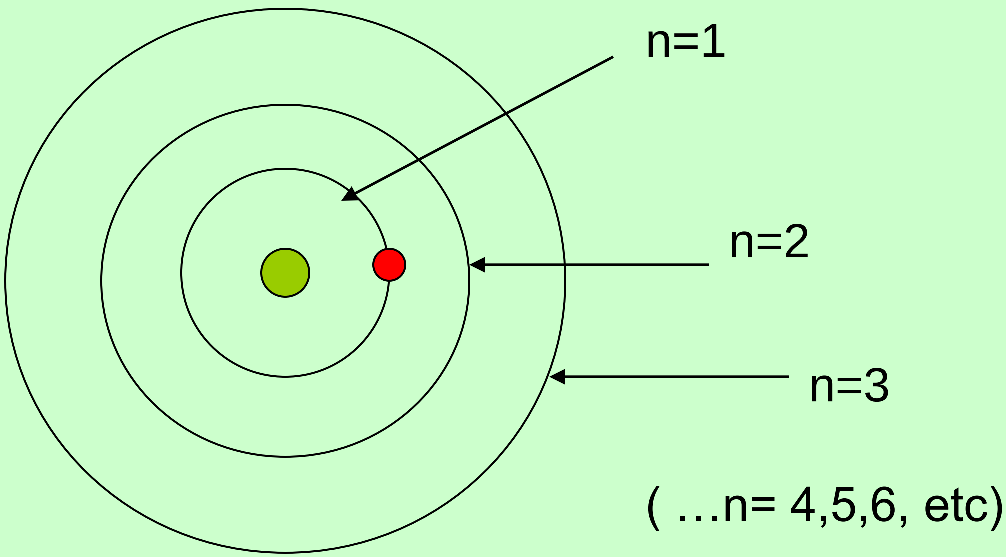
Within an atom there are electrons orbiting the nucleus…and…



Principal Quantum Number, n

An electron can be found in a certain "orbit" at a certain distance away from the nucleus

The "orbits" were named "**Principal Quantum Number**", "**n**"



Principal Quantum Number, n

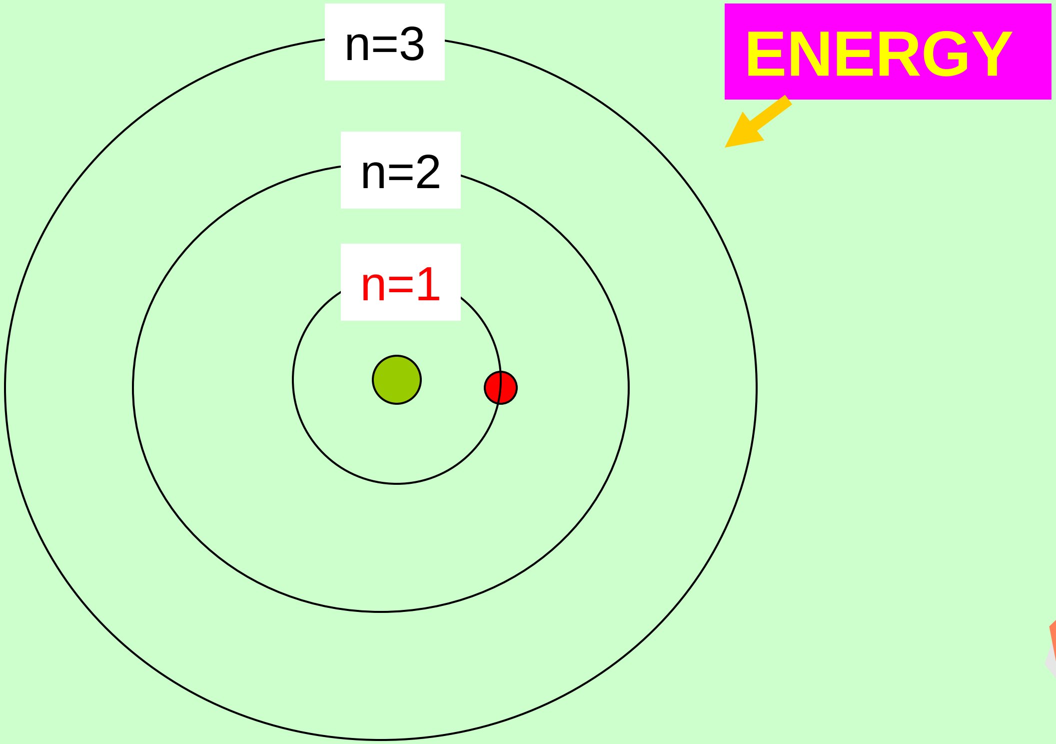
- The larger the value of n, the bigger the "orbital"
- The larger the value of n, the higher the energy that the electron will possess
- n must take on integer values *n* = 1, 2, 3, ...,

- **The maximum # of e- allowed in a Principal Quantum number is:** $2n^2$

# of electrons allowed in **n=1**: $2(1)^2$ = **2**
# of electrons allowed in **n=2**: $2(2)^2$ = **8**
# of electrons allowed in **n=3**: $2(3)^2$ = **18**
# of electrons allowed in **n=4**: $2(4)^2$ = **32**
# of electrons allowed in **n=5**: $2(5)^2$ = **50**
and so on…

<u>Principal Quantum Number, n</u>

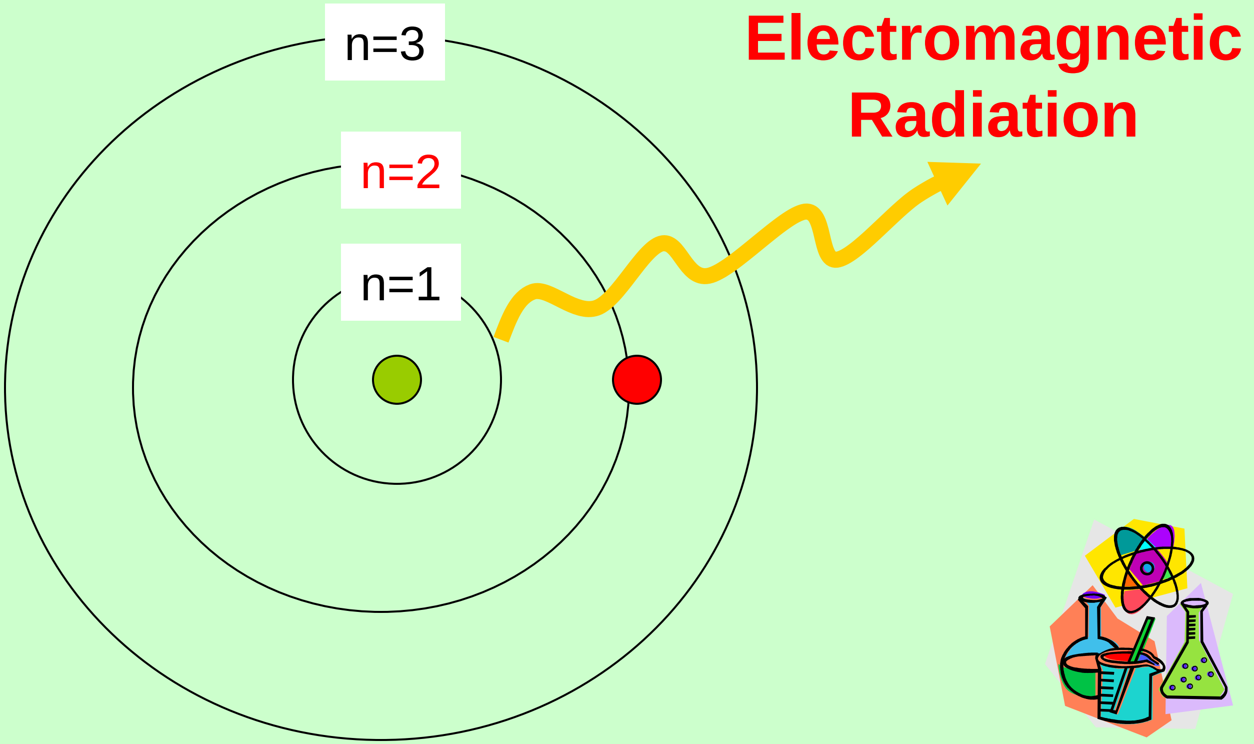
For an electron to move
<u>from a lower</u> quantum number
<u>to a higher</u> quantum number,
Energy would have to be **<u>ADDED</u>**.



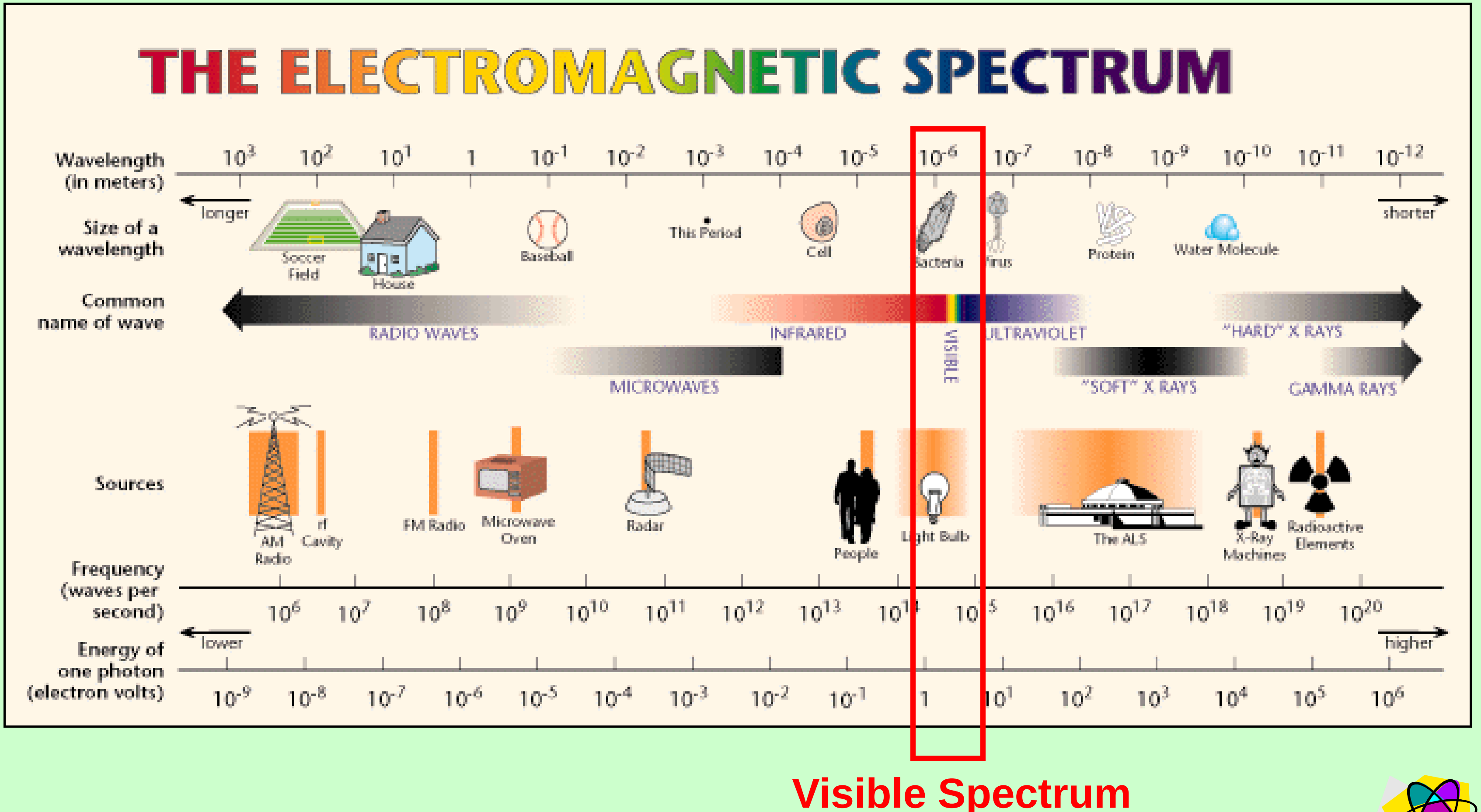
Principal Quantum Number, n

In the **higher** quantum number (orbit) and **with its energy**, the electron will eventually **fall back** to its original **lower** quantum number (orbit).

When it falls back, it will LOSE energy…in the form of… **Electromagnetic Radiation**.



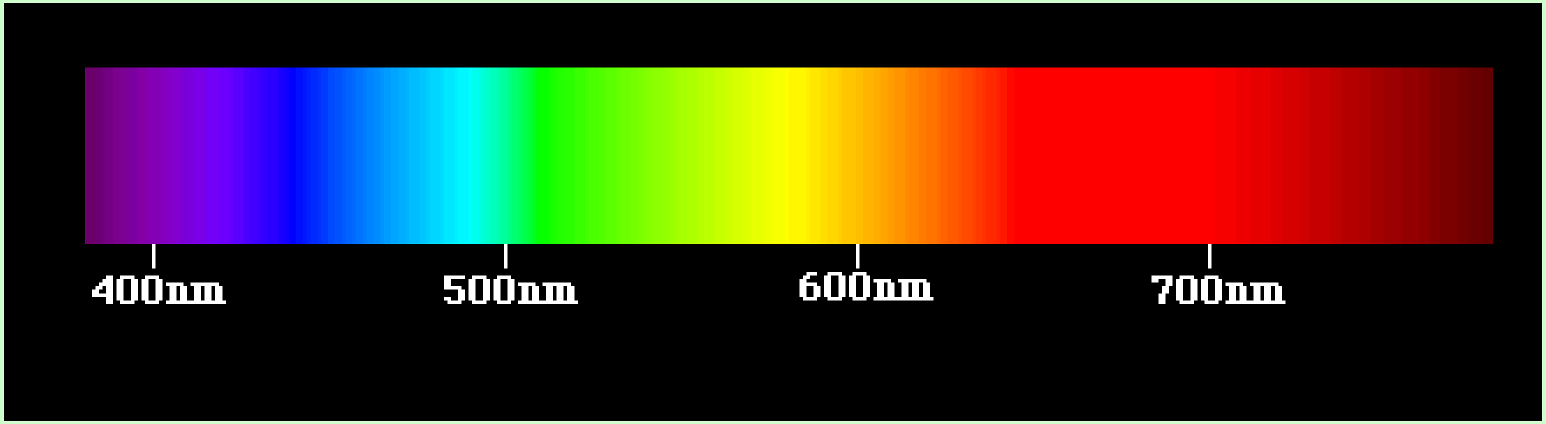
Electromagnetic Radiation



http://www.lbl.gov/MicroWorlds/ALSTool/EMSpec/EMSpec2.html

Visible & Hydrogen Spectra

Visible Spectrum

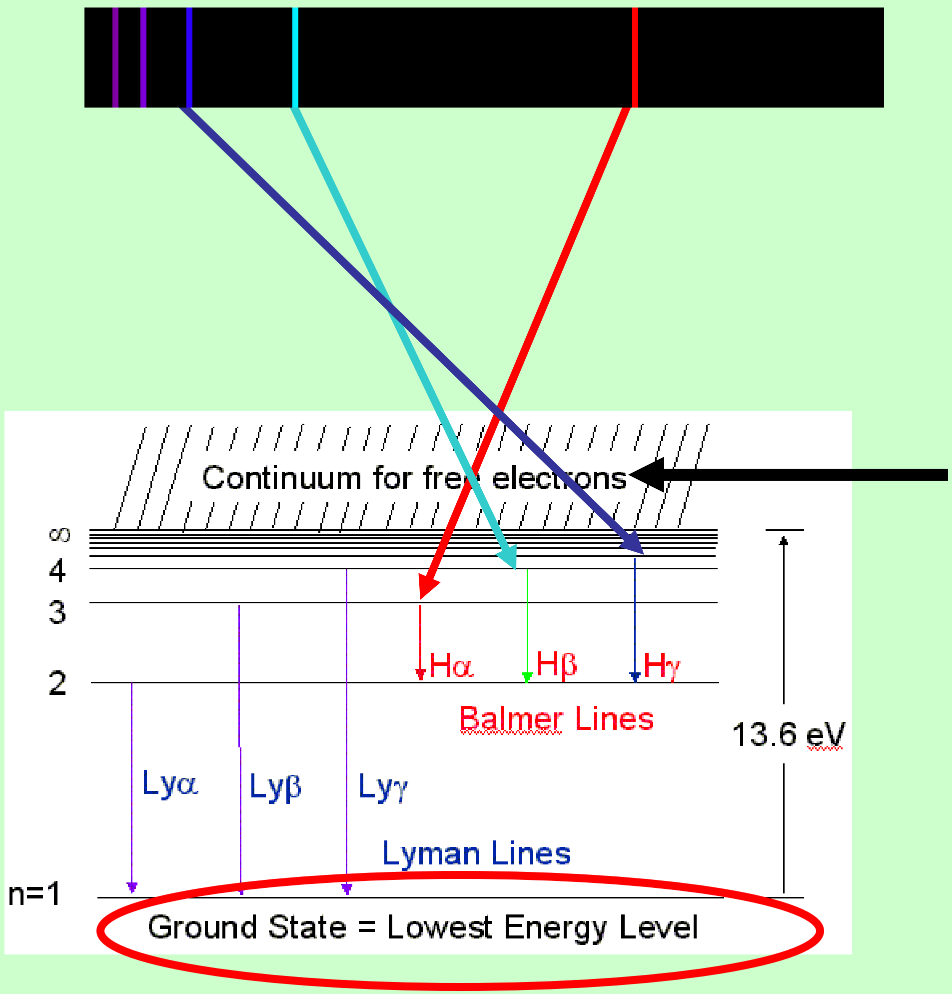


Emission Spectrum of Hydrogen

Emission Spectra of other element (click)

Hydrogen Spectrum

Bohr worked with hydrogen and his findings were based on <u>Hydrogen</u>



If enough energy is added to an electron, the electron will escape from the force of attraction of the proton and will escape the atom.

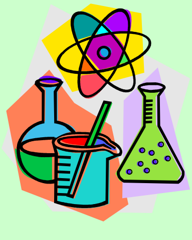
http://instruct1.cit.cornell.edu/courses/astro101/lec08.htm

Atoms with Many Electrons

The Bohr model works will with Hydrogen because
Hydrogen only has one electron

Bohr’s model does not work well for atoms with many electrons.
A more sophisticated model had to be developed

The concepts of **Sublevels** and **Spins** were added



Sublevels

The first modification was that the Principal Quantum Number be split into **"SUBLEVELS".**

The sublevels are: **s, p, d, f**

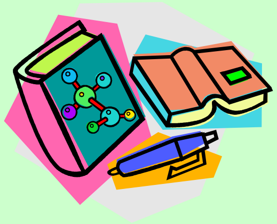
Where **s** contains electrons with lower energy and **f** contains electrons with higher energy

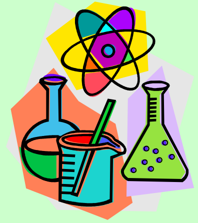
s sublevel can carry a max of **2 electrons**
p sublevel can carry a max of **6 electrons**
d sublevel can carry a max of **10 electrons**
p sublevel can carry a max of **14 electrons**

Some of the Principal Quantum Number do not have all of the sublevels

Example:

n=1	s
n=2	s, p
n=3	s, p, d
n=4	s, p, d, f





Sublevels

The number of electrons within a sublevel is shown as a superscript on top of the sublevel

Example

If **s** sublevel has **1 electron**, then $\mathbf{s^1}$

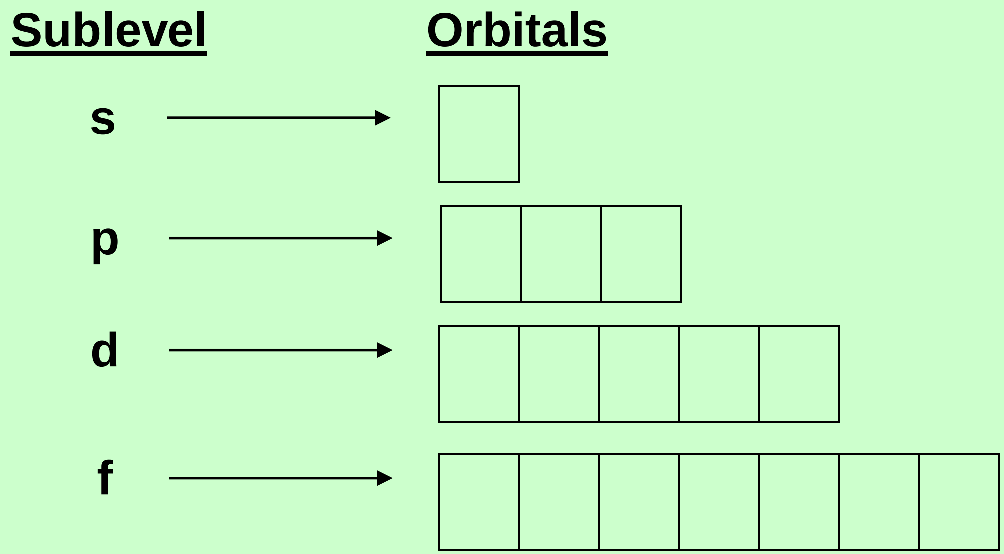
If **s** sublevel has **2 electron**, then $\mathbf{s^2}$

If **p** sublevel has **5 electrons** then $\mathbf{p^5}$

<u>Sublevels</u>

Within each sublevel, there are **<u>ORBITALS</u>**
Each orbital can fit max 2 electrons

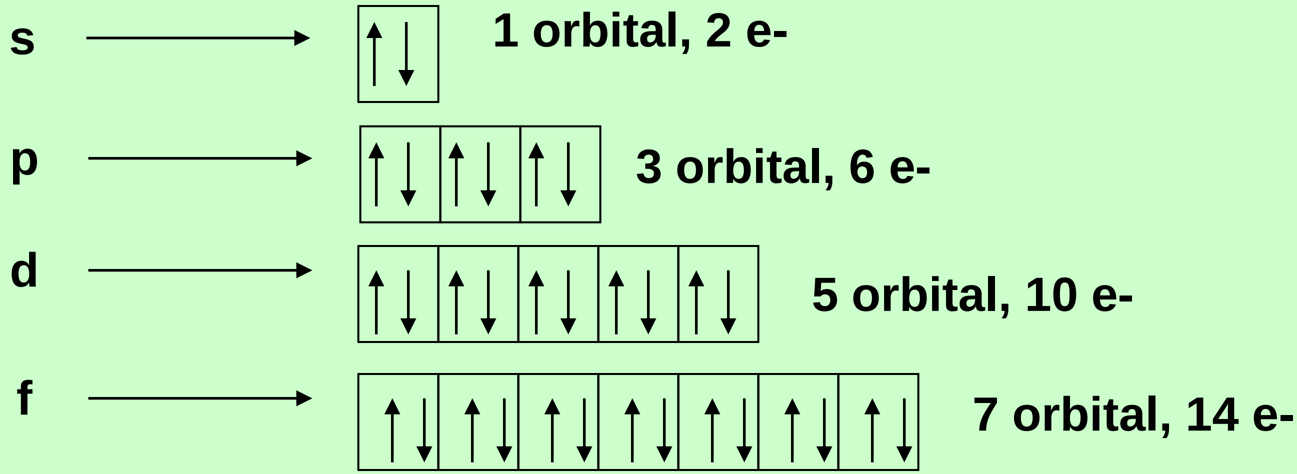
s sublevel → max of **2 electrons** → **1 orbital**
p sublevel → max of **6 electrons** → **3 orbitals**
d sublevel → max of **10 electrons** → **5 oribtals**
p sublevel → max of **14 electrons** → **7 orbitals**



Orbital & Electron Spins

Within each orbital, the 2 electrons have opposite spins (+/-)

Each small arrow represents an electron
Up & down directions represent the opposite spins



Orbital & Electron Spins

Every orbital within a sublevel must have atleast 1 electron before electrons begin to pair up within an orbital

Example: $\mathbf{p^4}$

↑↓	↑	↑

Example: $\mathbf{d^7}$

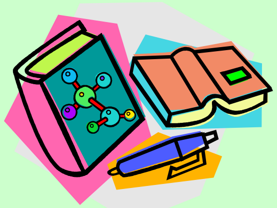
↑↓	↑↓	↑	↑	↑

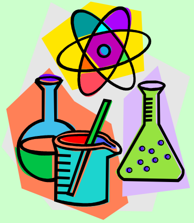
Example: $\mathbf{d^{10}}$

↑↓	↑↓	↑↓	↑	↑	↑	↑

Sublevels & Orbitals Energies

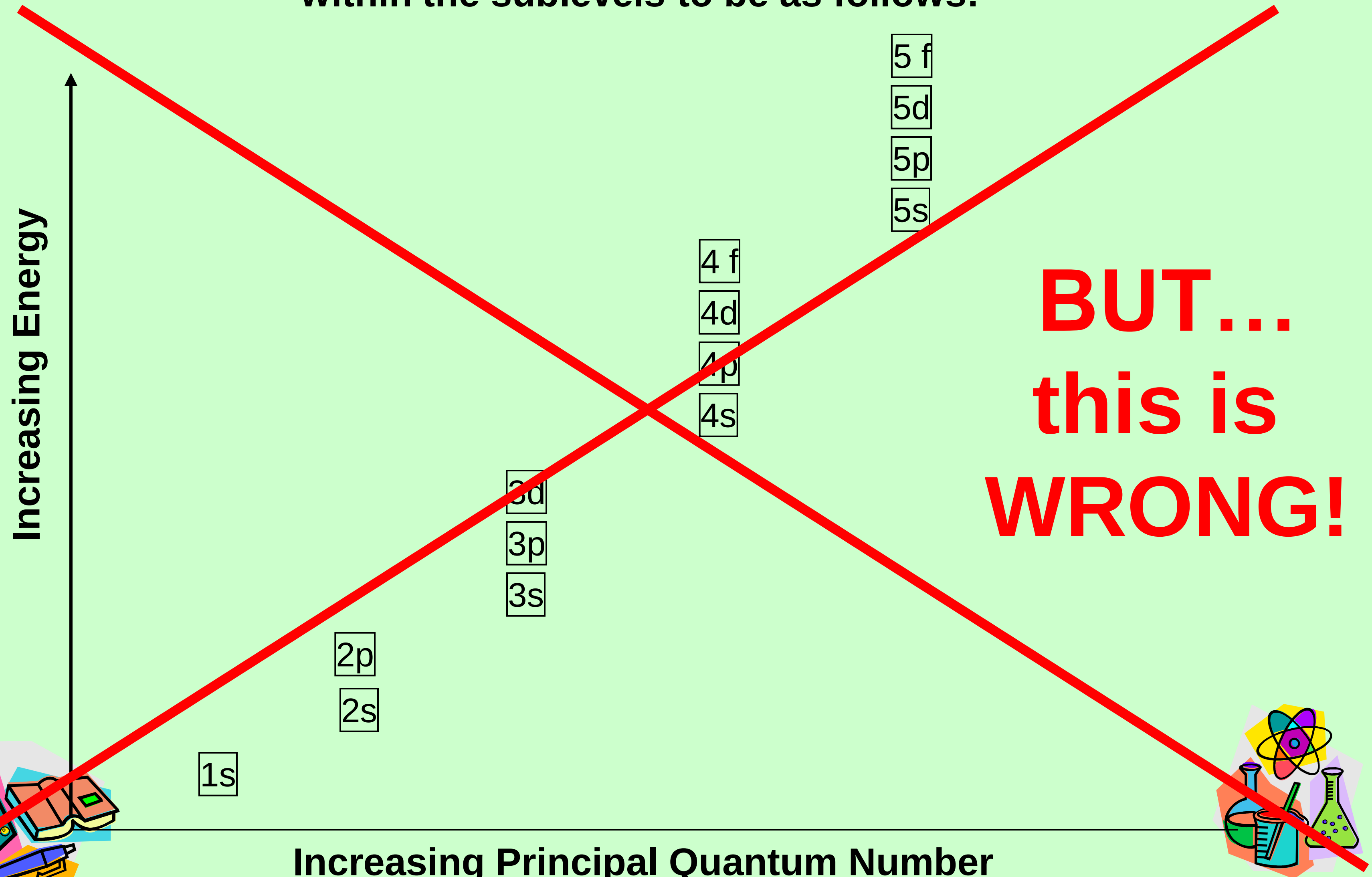
One reason that sublevels and orbitals were added was that some electrons within a lower principal quantum level would have more energy than electrons within a higher principal quantum level.





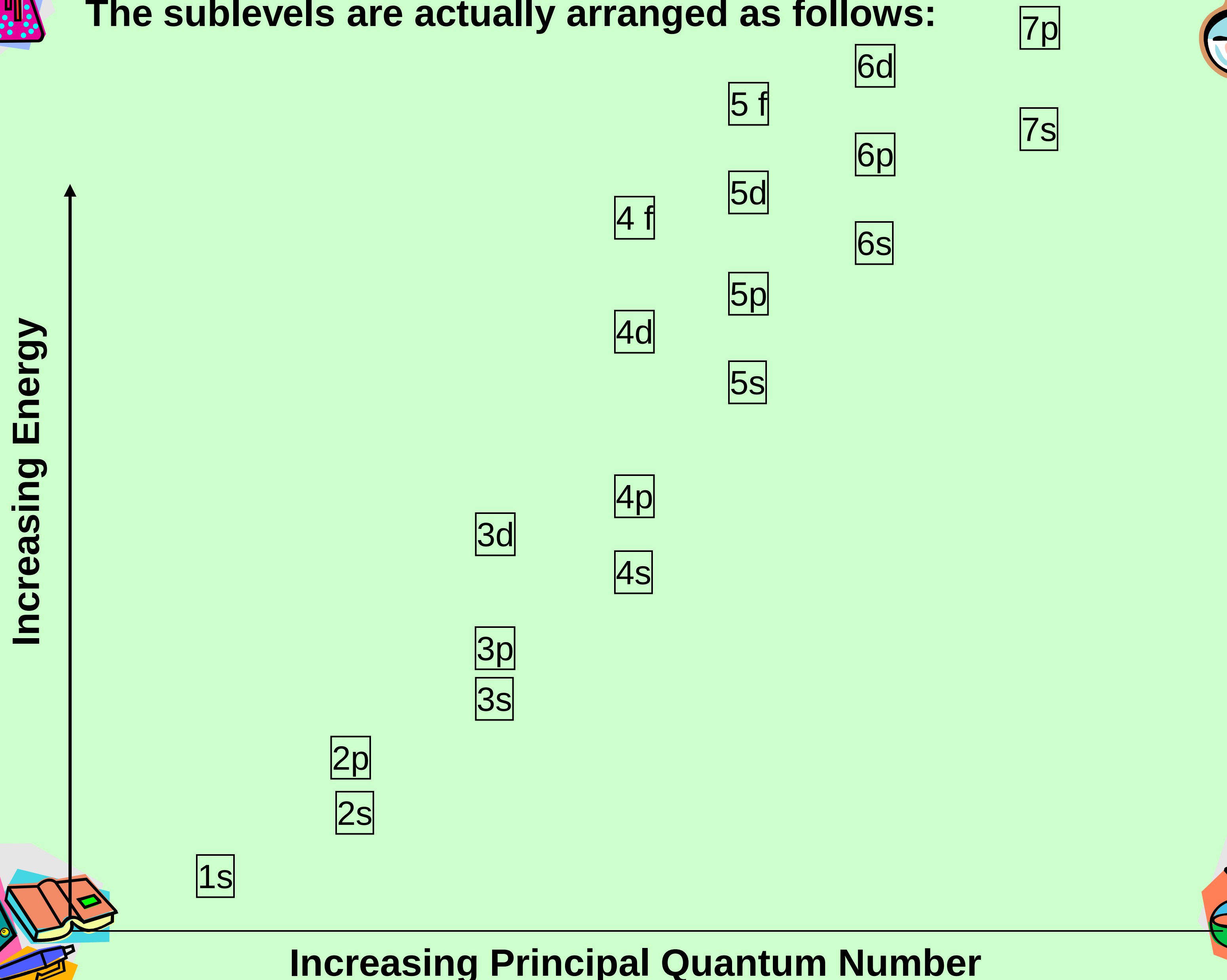
Sublevels & Orbitals Energies

One would think that the energies of the electrons within the sublevels to be as follows:



Sublevels

The sublevels are actually arranged as follows:



Sublevels

How can we figure out the order of the sublevels without the previous diagram?

Step 1: write out the principal quantum number and sublevels in the following way:

Step 2: Draw diagonal arrows starting from the right most sublevel to the left as follows

Step 3: Write out the sublevels in the order of the arrows from top to bottom

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p

Electron Configuration

The electron configuration of an atom is a form of notation which shows how the electrons are distributed among the various energy levels.

Remember that:

s → max 2 e-
p → max 6 e-
d → max 10 e-
f → max 14 e-

and

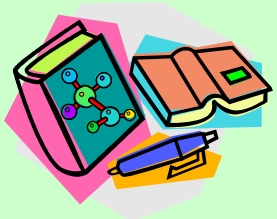
1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f
6s 6p 6d
7s 7p

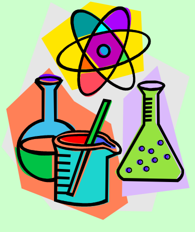
Examples:

Hydrogen: 1 e-
$1s^1$

Sodium: 11 e-
$1s^2\ 2s^2\ 2p^6\ 3s^1$

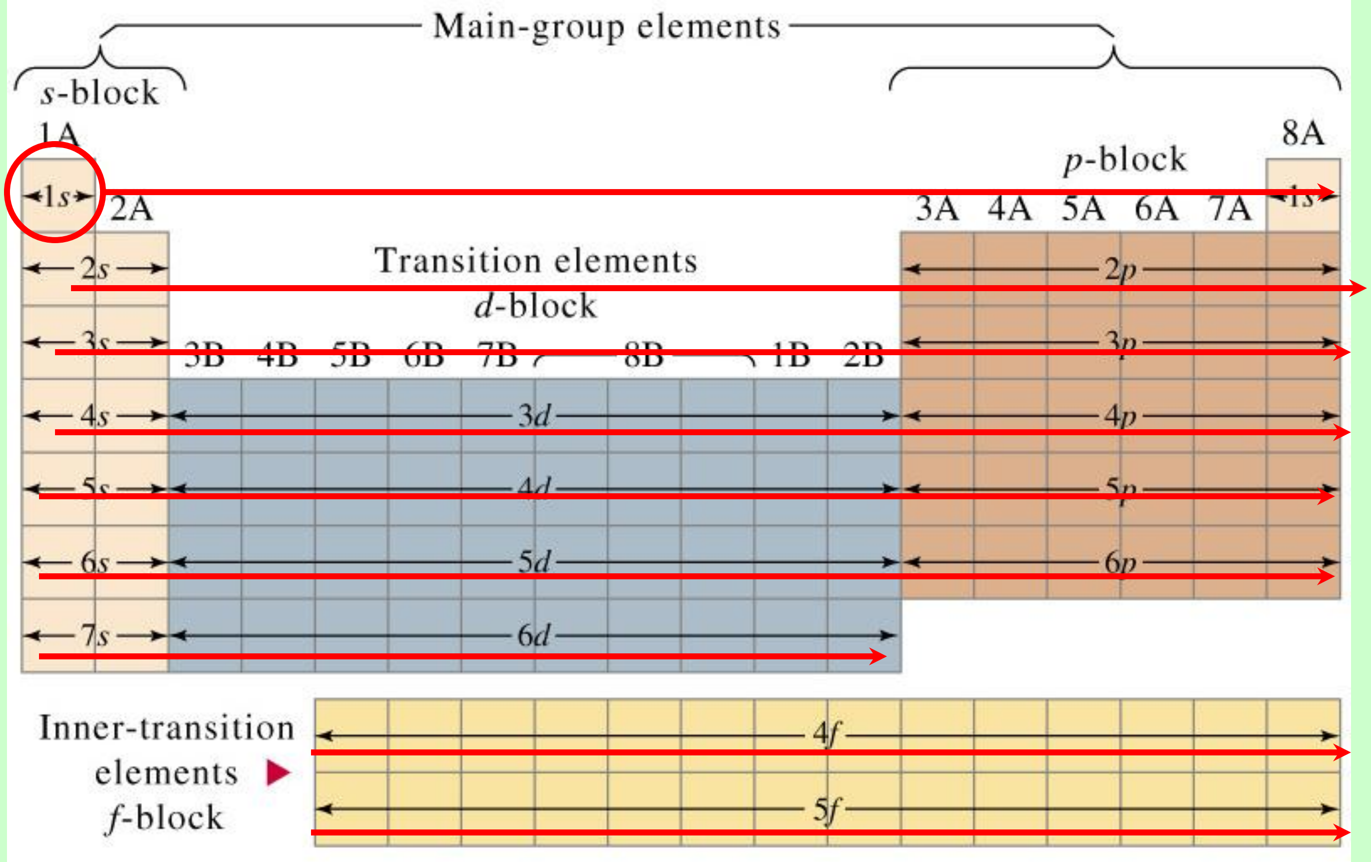
Calcium: 20 e-
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$





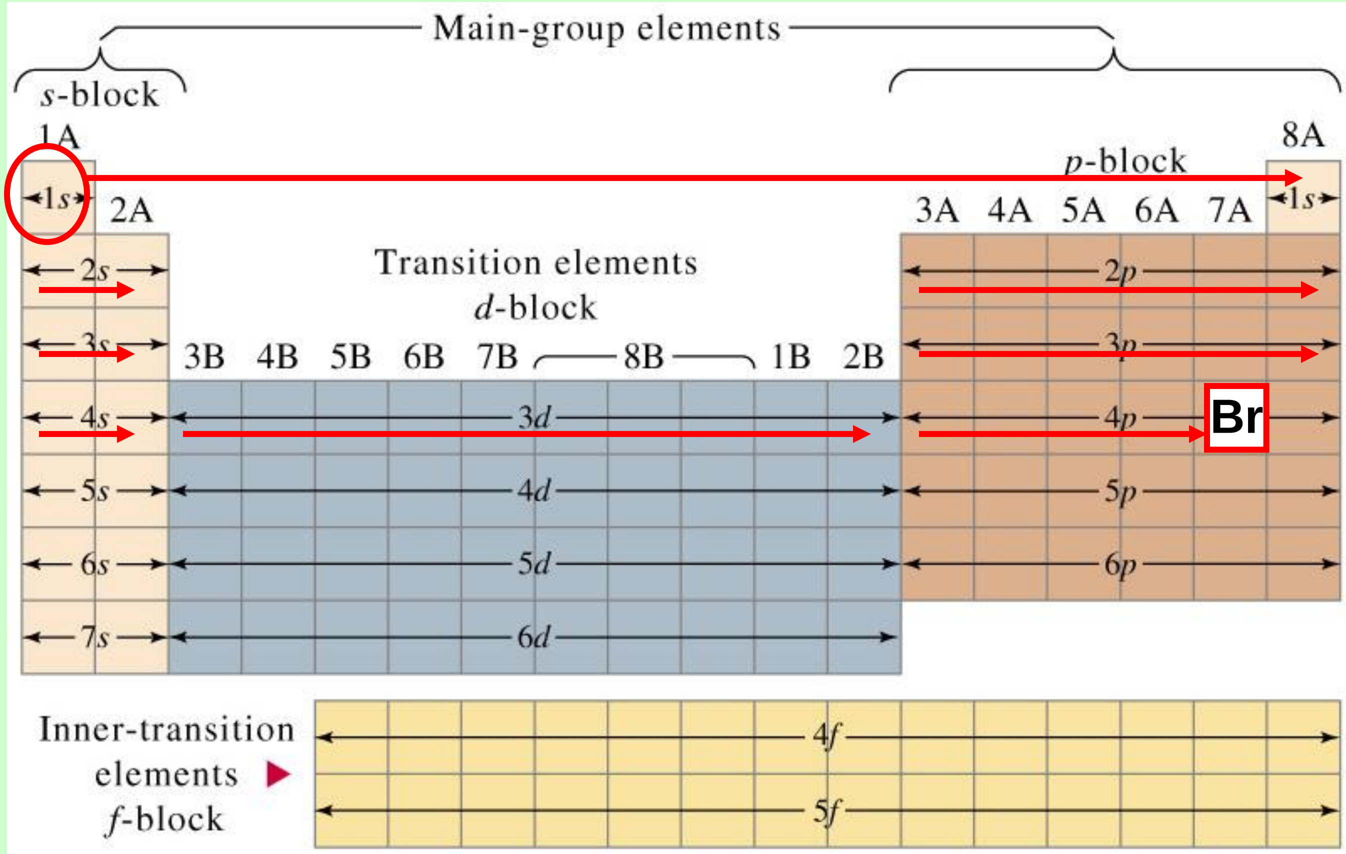
Electron Configuration

You can also use the periodic table to determine the e- config.



Locate the element on the periodic table
Start writing the configuration by starting with H.
Go across period 1, then down a period
And repeat

Electron Configuration



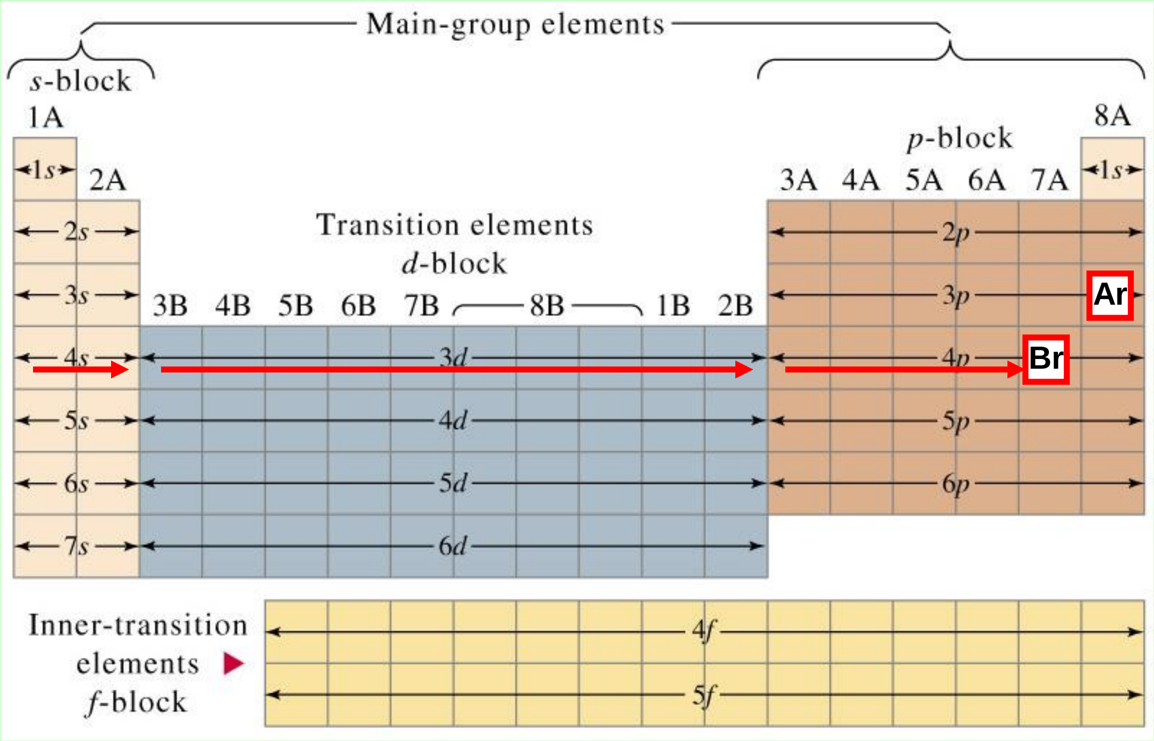
Example: Br:

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$ $4p^5$

Electron Configuration

One other way is use the electron configuration of the NOBLE GAS positioned BEFORE the element.

Write the noble gas symbol in square brackets [ ] followed by the remaining electron configuration



Example: Br   The noble gas before Br is Argon

[Ar] $4s^2$ $3d^{10}$ $4p^5$